Defense Information Systems Agency
Department of Defense

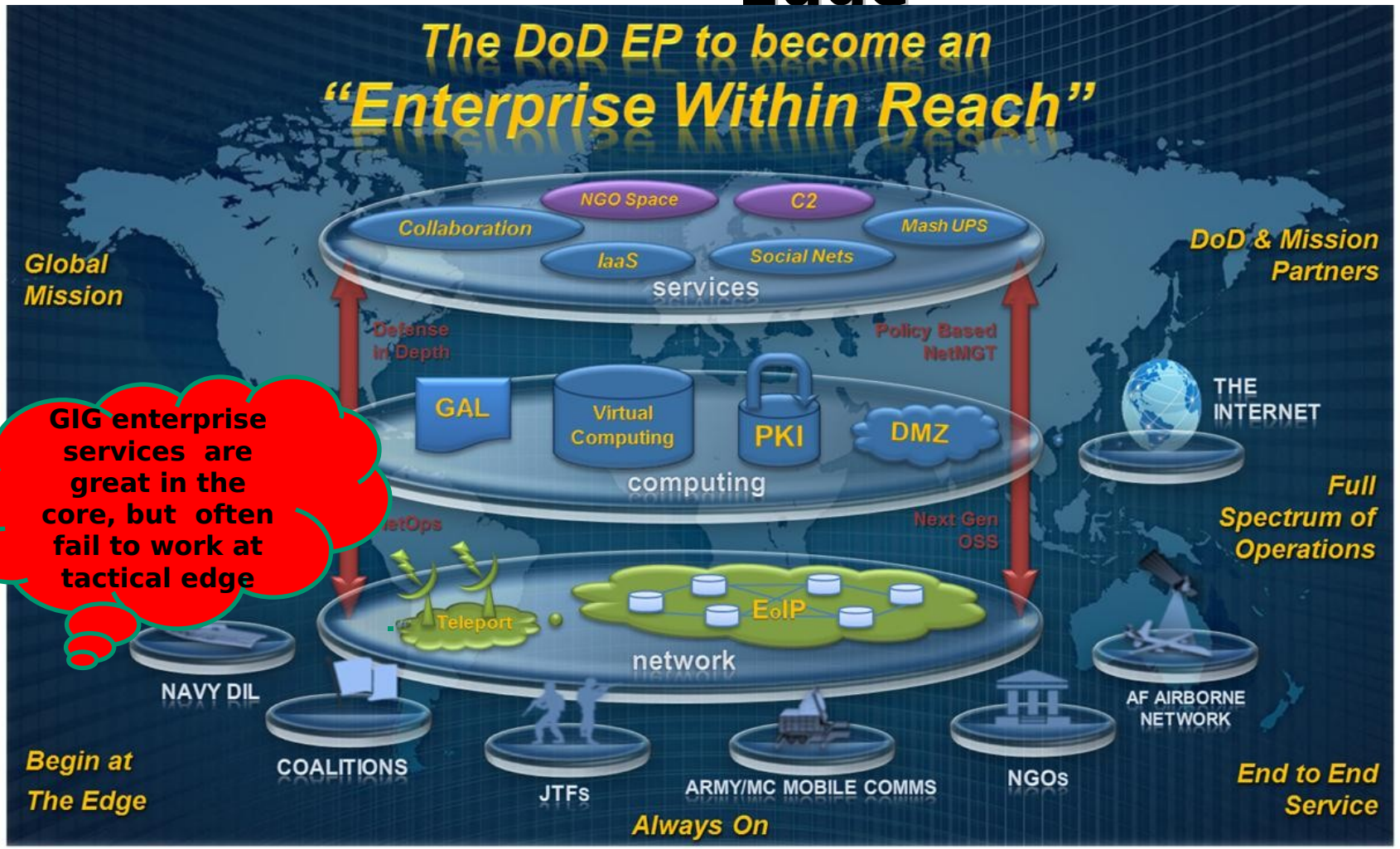
Tactical Edge Services
An EWSE Approach

August 17, 2011

Agenda

- Define Tactical Edge Service Problem
- Describe Tactical Edge Services
- Analyze Tactical Edge Frameworks (TEF)
- Describe Strategies and Technical Approaches to the Tactical Edge Service Problems
- Briefly Review EWSE Activities

DoD's Goal to Extend its Enterprise Service Capabilities to the Tactical-Edge*



*Tactical Edge as defined by VCJCS is the cockpit, tank, foxhole, not the nearest HQ

Defining Tactical Edge Service Problems

- **Most enterprise services developed for fixed and core environment will either fail to work at tactical edge, or function non-optimally at best.**
  - **Technological, operational and environmental constraints at tactical edge pose significant challenges for service development and deployment in the DoD tactical environment (to be described later).**
  - **Conventional service design architecture and approach fail to take into consideration the technical constraints in the tactical environment**
- **There is a pressing need for the strategies, techniques, design architectures and implementation guidance to support the effective service development and deployment at tactical edge.**

Technical Constraints in Tactical

- **Characterization of the Tactical Environment**
  - **Disconnected operation, intermittent connectivity, and limited bandwidth (DIL)**
  - **Ad-hoc and mobile networks**
  - **SATCOM and tactical radio communication links**
  - **Size, Weight and Power (SWaP) limitations**
- **Technical Constraints for Tactical Services**
  - **They are derived from those characteristics in the tactical environment.**
  - **They represent a limitation of design or performance parameters that are explicitly or implicitly imposed to the tactical service systems.**
  - **Tactical service design and network design can face somewhat different set of technical constraints.**
  - **Various techniques can be to utilized to overcome those constraints.**

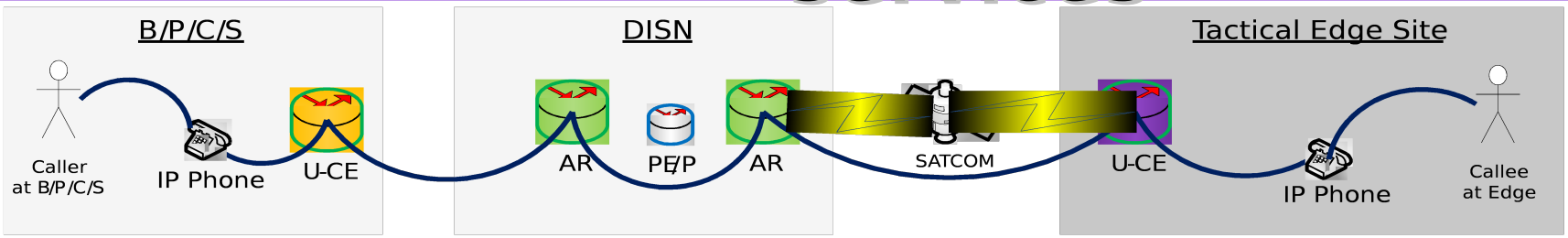
Defining Tactical Service Requirements

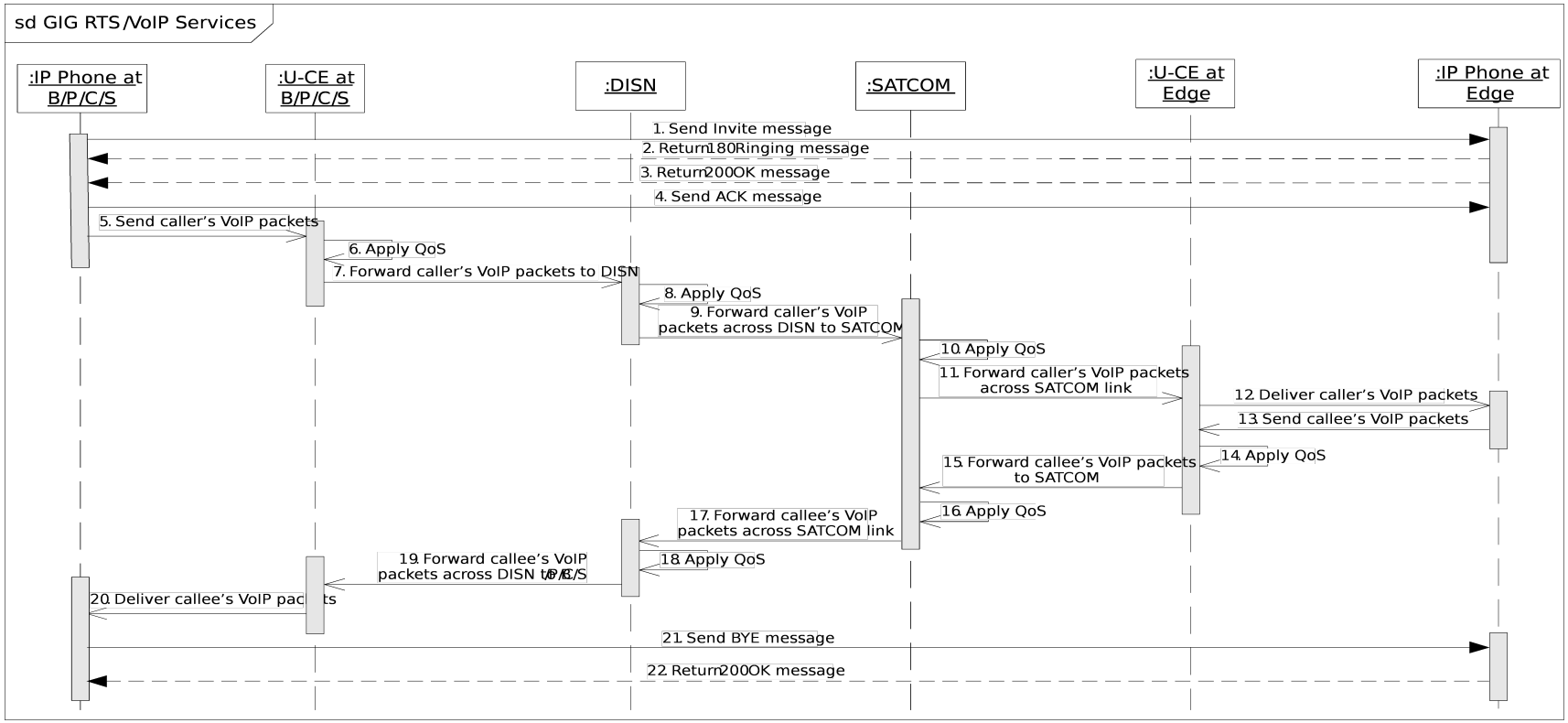
- **GIG Net-Centric and GIG 2.0 visions requirements**
  - **Support delivery of services for information collection, processing, dissemination and sharing capabilities to war-fighters anytime, anywhere and in proper format.**
- **Extended GIG Enterprise Services**
  - **Common enterprise services that are needed by and therefore are extended to the tactical users, e.g., e-mail and voice services.**
- **Services within Tactical Edge**
  - **Services that are developed directly from the war-fighting and tactical user requirements, and can be used by strategic users as well, e.g., Army's Casualty Report.**
- **Service Interoperability**
  - **The services implemented in the strategic environment (B/C/P/S) and the tactical environment need to be interoperable, i.e., compatible across service domains.**

Defining Tactical Edge Environment and Tactical Edge Service

- **Tactical Edge Environment**
  - **GIG tactical edge environment is characterized by a set of special operational, technological, network and resource limitations. Multiple types of tactical edge environments (or segments) can be defined based on location and associated constraint parameter values.**
  - **Tactical Edge Frameworks (TEF) is normally used to describe and characterize the tactical environments (to be described later).**
- **Tactical Edge Service**
  - **GIG services that are developed for and deployed in tactical edge environment, and primarily used by tactical users.**

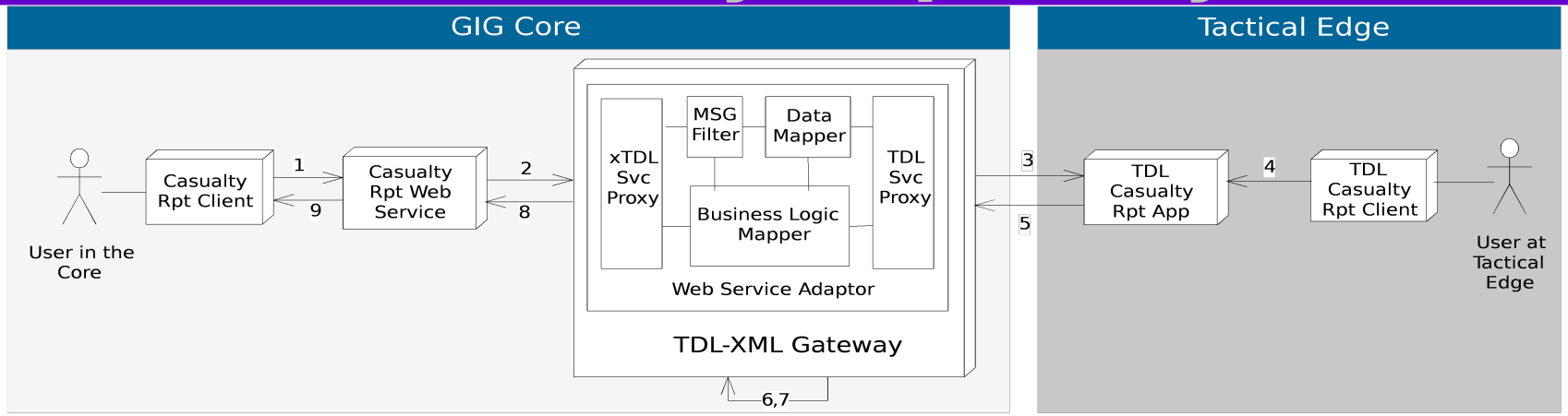
Example: GIG RTS/VoIP services

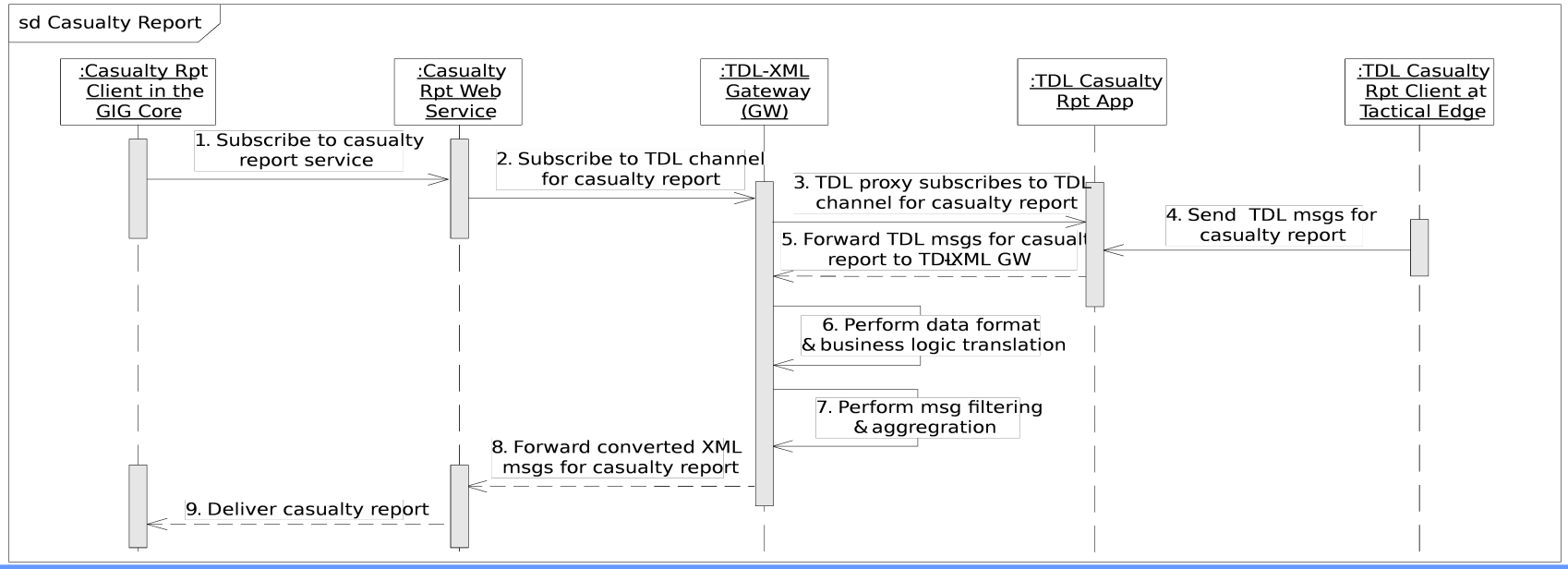



sd GIG RTS/VoIP Services
:IP Phone at B/P/C/S
:U-CE at B/P/C/S
:DISN
:SATCOM
:U-CE at Edge
:IP Phone at Edge
1. Send Invite message
2. Return 180 Ringing message
3. Return 200 OK message
4. Send ACK message
5. Send caller's VoIP packets
6. Apply QoS
7. Forward caller's VoIP packets to DISN
8. Apply QoS
9. Forward caller's VoIP packets across DISN to SATCOM
10. Apply QoS
11. Forward caller's VoIP packets across SATCOM link
12. Deliver caller's VoIP packets
13. Send callee's VoIP packets
14. Apply QoS
15. Forward callee's VoIP packets to SATCOM
16. Apply QoS
17. Forward callee's VoIP packets across SATCOM link
18. Apply QoS
19. Forward callee's VoIP packets across DISN to B/C/S
20. Deliver callee's VoIP packets
21. Send BYE message
22. Return 200 OK message

End-to-End RTS/VoIP From B/C/P/S to Tactical edge

Example: Near Real-Time Army Casualty Report System

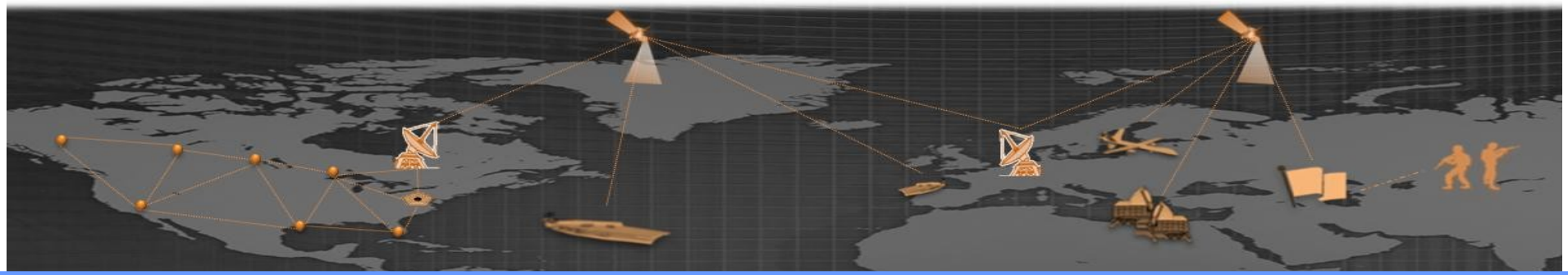



sd Casualty Report
:Casualty Rpt Client in the GIG Core
:Casualty Rpt Web Service
:TDL-XML Gateway (GW)
:TDL Casualty Rpt App
:TDL Casualty Rpt Client at Tactical Edge
1. Subscribe to casualty report service
2. Subscribe to TDL channel for casualty report
3. TDL proxy subscribes to TDL channel for casualty report
4. Send TDL msgs for casualty report
5. Forward TDL msgs for casualt report to TDL-XML GW
6. Perform data format & business logic translation
7. Perform msg filtering & aggregration
8. Forward converted XML msgs for casualty report
9. Deliver casualty report

Tactical Service Available to Both Tactical and Strategic users

Defining GIG Service Capability Spectrum

DoD Computing and Communications Framework	CORE						Intermediate					Tactical Edge							
	Data Center Internal LAN/SAN	Security Boundary /Firewall	Transport-Teleport >>>	Teleport <<<Receiver	Wired Interconnect	WGS >>> Terminal	<<< WGS Terminal	Wired Interconnect	Gateway	Wired Interconnect	HNW >>> Radio 10Mbps	<<< HNW Radio 10 Mbps	Gateway	WNW Radio 2Mbps >>>	WNW Radio <<< 2Mbps	Gateway	SRW Radio 0.8 Mbps >>>	BRW Radio 0.8 Mbps <<<	Local Gateway	Local Application
Network Protocols:	**Global Fixed Assets**			**Mobile In-Theater Assets**			**Large Ship**		**Brigade**		**Support Ship**	**Battalion**			**Company**				**Platoon**	
TCP across WAN	TCP –SCPS enhanced or other modifications to handle different context																			
UDP	UDP –Lacks guaranteed delivery and flow control mechanisms which must be accounted for somewhere else (e.g. DTN or in the application)																			
DTN												DTN –Needs flow control that cooperates with other protocols							
Appls Protocols:																				
SOAP	SOAP –Use compression techniques –Needs standardization																			
SMTP	SMTP –Needs enforced policy regarding attachments, compression, message header retrieval																			
XMPP	XMPP –Needs compression or conversion into lighter weight protocol to effectively steward resources																			
Binary RPC																				
Services:																				
Messaging	ugment infrastructure w/protocol conversion gateway, fwd caching & segmented queue																			
Email	E-mail -Policy based access to large attachments, retrieve header only, compression																			
CDS	CDS -hosted close to users has better performance but requires more monitoring & remote admin																			
ID	ID -Policy based tolerance to latest updates to certificate revocation list																			
Chat Server	Chat –Needs bandwidth efficiency improvements																			
Map Server	Map Server -Subsetted based on geographic, temporal & mission context & most recent data																			
Discovery	Service registry																			
C2 Data Needs:																				
Blue SA, Red SA, Control Measures, Status Reports, Orders																				
Collaboration Needs:																				
Voice																				
Text Chat																				
File Sharing																				
Video																				
File Sharing																				



OSD/NII's View of Services and Network Environments: Core, Intermediate and Tactical Edge

Tactical Edge Framework (TEF)

- **Tactical Edge Framework is developed as a technical framework to describe the characteristics and constraints of the tactical environment.**
- **Many variations of Tactical Edge Frameworks have been developed within the GIG community.**
  - **MITRE TEF**
  - **JC2 Tactical Edge Model**
  - **Army Model**
  - **USMC TEF**
  - **JHU/APL Model**
- **Focus of the framework should be the "zones" as defined by a set of technical constraint parameters vs. operation segments.**
  - **Different constraint parameters in the same segment impose different levels of technical difficulty**

MITRE Tactical Edge Framework (TEF)

Tactical Edge Environments

Characterization Attributes			Tactical Fixed Center	Tactical Mobile Center	Mobile Platform	Dismounted User
	LAN Network	Connectivity	>85%	>85%	25-84%	5-24%
		Latency	<250ms	<250ms	>250ms	>250ms
		Bandwidth	128 kbps-100 Mbps	128 kbps-100 Mbps	1-128kbps	1-128kbps
		Reliability	>90%	>90%	>90%	>90%
		Predictability	Predictable	Mostly Predictable	Less predictable	unpredictable
	WAN Network	Connectivity	>99%	85-99%	25-84%	<5%
		Latency	<250 ms	250-1000 ms	250-1000 ms	>1000 ms
		Bandwidth	<20 Mbps	128-1 Mbps	128-256 kbps	9.6-64 kbps
		Reliability	>99%	>75%	<75%	<75%
		Predictability	Predictable	Predictable	Less predictable	Less predictable
	System	Standard User Interface	Desktop - laptop	Desktop - laptop	Laptop - tablet- handheld	Laptop - tablet- handheld
		Processing	Servers - workstations	Servers - workstations	Single stations - handhelds	Single stations - handhelds
		Storage	Large data storage devices	Large data storage devices	Single hard drives	Single hard drives
		Ruggedness	Few ruggedness considerations	Few ruggedness considerations	Many ruggedness considerations	Many ruggedness considerations
		Size	>10 sq ft	>10 sq ft	<10 sq ft	<3 sq ft
		Weight	100s lbs	100s lbs	10 - 100 lbs	<10 lbs
		Power	Grid, macro generator	Generator - batteries	Generator - batteries	batteries
	Environment	HVAC	HVAC	None	None	None
		Lighting	Controlled	Controlled	variable	Variable
		Hazards	Dirt/salt/fog	Dirt/salt/fog	Dirt/salt/fog/heat/cold/physical	Dirt/salt/fog/heat/cold/physical
	Operational	Reparability	Spares available	Some spares available	No spares available	No spares available
		Decision Timelines	Minutes - weeks	Minutes - days	Seconds - minutes	Seconds - minutes
		Content	Complex	Complex	Intermediate	Simplified
		System Training	Extensive - intermediate	Extensive - intermediate	Intermediate - minimal	Intermediate - minimal
	Security	Confidentiality	Insider threat, packet sniffers	Transmission interception	Transmission interception	Capture
		Integrity	Viruses	Transmission error	Transmission error	Spoofing
		availability	Denial of service	Denial of service	jamming	Capture, damage

Minimal to no

Moderate constraint

Severe consttraint

JC2 Tactical Edge Model

			DL-	I-L	IL	DL
			Tactical Layer #1	Tactical Layer #2	Tactical Layer #3	Tactical Layer #4
Network	Local	Connectivity	Well Connected	Well Connected	Intermittently Connected	Mostly disconnected
		Latency	Low	Low	Medium/Low	Medium/Low
		Bandwidth	High	High	Medium/Low	Medium/Low
	Global	Connectivity	Well Connected	Well Connected	Intermittently Connected	Mostly disconnected
		Latency	Low	Medium/Low	Medium/Low	Virtually Unlimited
		Bandwidth	High	Medium/Low	Medium/Low	Virtually None

Layer 1 DL⁻: Well-connected and high bandwidth environment
Layer 2 I-L: Limited bandwidth but well-connected environment
Layer 3 IL: Intermittent connectivity and limited bandwidth environment
Layer 4 DL: Disconnected and Limited bandwidth environment.

USMC Tactical Edge Framework

Convergence Study Network Model		GIG Core	Broadband				Narrowband	User Access
MAGTF Capability Set			CAPSET I	CAPSET II	CAPSET III	CAPSET IV	CAPSET V	
Echelon			MEF	DIV	REG	BN	CO	PLT and below
JC2 Architecture			JC2 Tactical Layer 1			JC2 Tactical Layer 2	JC2 Tactical Layer 3	JC2 Tactical Layer 4
Tactical Edge Framework Group			Tactical Fixed Center			Tactical Mobile Center	Mobile Platform	Dismounted User
LAN Network	Connectivity	well connected	> 85%			> 85%	25 - 84%	5 - 24%
	Latency	low	< 250 ms			< 250 ms	> 250 ms	> 250 ms
	Bandwidth	high	128 kbps - 100 Mbps			128 kbps - 100 Mbps	1 - 128kbps	1 - 128 kbps
	Reliability	reliable	> 90%			> 90%	> 90%	> 90%
	Predictability	predictable	predictable			mostly predictable	less predictable	unpredictable
WAN Network	Connectivity	well connected	> 99%			85 - 99%	25 - 84%	< 5%
	Latency	low	< 250 ms [LOS] 500-600 ms [Sat]		< 250 ms [LOS] 650 - 800 ms [Sat]	< 250 ms [LOS] 650 - 800 ms [Sat]	< 250 ms [LOS] 1000 ms [Sat]	< 250 ms [LOS] 1000 ms [Sat]
	Bandwidth	high	< 20 Mbps [Sat: Ku, Ka, EHF, X, C] < 16 Mbps [LOS: UHF, SHF: Tropo]		< 16 Mbps [LOS UHF] < 8 Mbps [Sat Ku, EHF]	< 16 Mbps [LOS UHF] < 4 Mbps [Sat Ku]	< 2.6/16/486 kbps [LOS HF/VHF/UHF] < 2.6/19/120 kbps/8 Mbps [Sat L (BFT)/UHF/L/Ku]	< 2.4/16 kbps [LOS HF/VHF] < 2.6/60 kbps [Sat L (BFT)/L]
	Reliability	reliable	>90%			> 75%	< 75%	< 75%
	Predictability	predictable	predictable			predictable	less predictable	less predictable
System	Standard User Interface	desktop - laptop	desktop - laptop			desktop - laptop	tablet - handheld	tablet - handheld
	Processing	servers - workstations	servers - workstations			servers - workstations	single workstations - handhelds	single workstations - handhelds
	Storage	large data storage devices	large data storage devices			large data storage devices	single hard drives	single hard drives
	Ruggedness	few ruggedness considerations	less rugged			less rugged	more rugged	more rugged
Environment	Size	not limiting	> 10 sq ft			> 10 sq ft	< 10 sq ft	< 3 sq ft
	Weight	not limiting	100s lbs			100s lbs	10 - 100 lbs	< 10 lbs
	HVAC	HVAC	HVAC			none	none	none
	Power	grid, macro generator	grid, macro generator			generator - batteries	generator - batteries	batteries
	Lighting	controlled	controlled			controlled	variable	variable
	Hazards	few ruggedness considerations	dirt/salt/fog			dirt/salt/fog	dirt/salt/fog/heat/cold/physical	dirt/salt/fog/heat/cold/physical
Operational	Repairability	space available	spares available			some spares available	no spares available	no spares available
	Decision Timelines	somewhat limited	mins - wks			mins - days	seconds - minutes	seconds - minutes
	Content	intermediate - complex	complex			complex	intermediate	simplified
	System Training	extensive - intermediate	extensive - intermediate			extensive - intermediate	intermediate - minimal	intermediate - minimal
Security	Confidentiality	insider threat, packet sniffers	insider threat, packet sniffers			transmission interception	transmission interception	capture
	Integrity	Servers - workstations	viruses			transmission errors	transmission errors	spoofing
	Availability	denial of service	denial of service			denial of service	jamming	capture, damage

minimal to no constraints | moderate constraints | severe constraints | not applicable

Army Tactical Model

Mission Environments	Computing Environments
Enterprise - Post/Camp/Station • High bandwidth • High availability server-class machines • Highly controlled environment • Fixed location	
Command Post • Moderate to high bandwidth • Server-class machines • Semi-controlled environment • Temporary location	
Mounted • Low to moderate bandwidth • PC-class machines • Minimally controlled environment • Dynamic location	
Soldier/Sensor • Low to moderate bandwidth • Smartphone and tablet-class devices • Uncontrolled environment • Dynamic location	

- The Mission Environments in which soldiers operate are differentiated by varying network bandwidth, computing power, environmental factors and location permanence.
- Each Mission Environment is supported by a limited number of standardized Computing Environments that provide needed capability and integration with other Computing Environments.

JHU/APL Tactical Edge Model

Tactical Edge Constraints	Intermediate Layer			Tactical Edge Layer		
	Large Ship	**Brigade**	**Support Ship**	**Battalion**	**Company**	**Platoon**
SWaP: Size, Weight, Power	Long term Installations, Rack Mounted Systems	Dedicated Truck with Rack systems	Long term Installations, Rack Mounted Systems	Dedicated Truck with Rack systems	Vehicle Mounted Blade Rack	Laptop/Tablet
Storage	Nearly Unlimited	~50TB	Nearly Unlimited	~10TB	~500GB	~160GB
Computing	Nearly Unlimited	<900 Spec	Nearly Unlimited	<300 Spec	<300 Spec	<30 Spec
SATCom Connection	2013: 4 Mbps FDMA 512 Kbps AEHF	2013: 4 Mbps FDMA (Dedicated) 2010: 4 Mbps FDMA	2013: 128 Kbps Iridium 256 Kbps AEHF	2013: <3 Mbps FDMA (Shared) 2010: 0.5 Mbps TDMA (Shared)	2013: 128 Kbps NCW (Shared) 2010 : 300 bps	2013: 9.6 Kbps MUOS 2010: 300 bps
Upstream Connection	None	2013: 10 Mbps HNW 2010: 2 Mbps	None	2013: 10 Mbps HNW 2010: 2 Mbps	2013: 2 Mbps HNW 2010: 0	2013: 0.6 Mbps SRW 2010: 0
Downstream Connection	None	2013: 10 Mbps HNW 2010: 2 Mbps	None	2013: 2 Mbps WNW 2010: 0	2013: 0.6 Mbps SRW 2010: 0	N/A

Segment Comparison of Different GIG Tactical Edge Frameworks

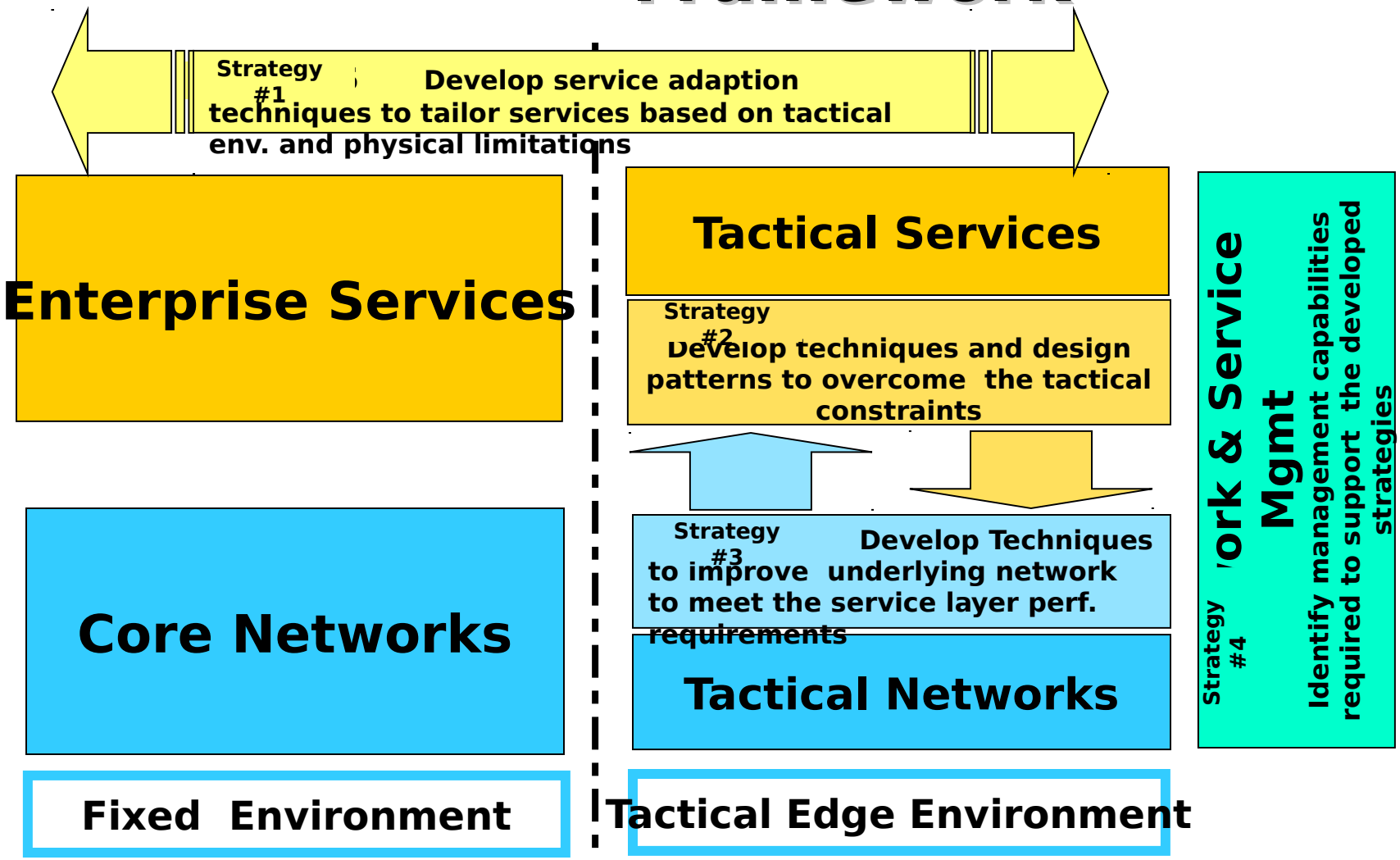
MITRE	JC2	USMC	Army	JHU/APL
Tactical Fixed Center	JC2 Tactical Layer 1	Marine Expeditionary Force, Division and Regiment	Command Post	Fixed but Mobile in-theater Assets
Tactical Mobile Center	JC2 Tactical Layer 2	Battalion		Intermediate: Large Ship, Brigade, and Support Ship Tactical Edge: Battalion
Mobile Platform	JC2 Tactical Layer 3	Company	Mounted	Tactical Edge: Company
Dismounted User	JC2 Tactical Layer 4	Platoon and below	Soldier/Sensor	Tactical Edge: Platoon

DISA EWSE Tactical Constraint Model

Navy Echelon				Large Ship and Support Ship		
Army Echelon			Theater	BGD and BN	CO	PLT and below
USMC Echelon			MEF, DIV, REG	BN	CO	PLT and below
Tactical Edge Constraints			Tactical Fixed Center	Tactical Mobile Center	Mobile Platform	Dismounted User
Network	Bandwidth	SATCOM	Army/Navy: nearly unlimited Marine: <8/20Mbps	Army: <3/4 Mbps (2013) 0.5/4 Mbps (now) Navy: 128/256/512Kbps/ 4Mbps (2013) Marine: <4 Mbps	Army: 0.3Kbps(now), 128Kbps(2013) Marine: <2.6/19/120Kbps /8Mbps	Army: 0.3Kbps(now), 9.6Kbps(2013) Marine: <2.6/60Kbps
		WAN	Army/Navy: nearly unlimited Marine: <16Mbps	Army: 2Mbps(now), 10Mbps(2013) Navy: None Marine: <16Mbps	Army: 128-256Kbps(now), 0.6-2Mbps(2013) Marine: <2.6/16/486Kbps	Army: 9.6-64Kbps(now), 0.6Mbps(2013) Marine: <2.4/16Kbps
	Connectivity	LAN	>85%	>85%	25-84%	5-24%
		WAN	>99%	85-99%	25-84%	<5%
	Latency	LAN	<250ms	<250ms	>250ms	>250ms
		WAN	<250ms	250-1000ms	250-1000ms	>1000ms
	Reliability	LAN	>90%	>90%	>90%	>90%
		WAN	>90%	>75%	<75%	<75%
System	User Interface		desktop-laptop	desktop-laptop	laptop-tablet-handheld	laptop-tablet-handheld
	Processing Power		nearly unlimited	300-900 spec int	<300 spec int	<30 spec int
	Storage		nearly unlimited	~10-50TB	~500GB	~160GB
	Weight		100s lbs	100s lbs	10-100 lbs	< 10 lbs
	Power		grid, macro generator	generator - batteries	generator -batteries	batteries
Operational	Decision Time		minutes - weeks	minutes - days	seconds -minutes	seconds - minutes
	Content		complex	complex	intermediate	simplified
	Mobility		fixed	occasional move	frequent move	frequent move

- Tactical edge environment can be characterized and segmented based on tactical environments and constraints as defined by network, system, and operational parameters.

Technical Approach Framework


Strategy #1
Develop service adaption techniques to tailor services based on tactical env. and physical limitations
Enterprise Services
Tactical Services
Strategy #2
Develop techniques and design patterns to overcome the tactical constraints
Strategy #3
Develop Techniques to improve underlying network to meet the service layer perf. requirements
Core Networks
Tactical Networks
Strategy #4
ork & Service Mgmt
Identify management capabilities required to support the developed strategies
Fixed Environment
Tactical Edge Environment

Technical Solution Strategies

- **Utilize Service Adaptation**
  - **Use Tiered Service Model to adapt to different tactical environments.**
  - **Deploy Service Proxy Gateway between different tactical service domains and between the tactical and fixed core services domains to make them adapted to one another.**
  - **Utilize Service Broker concept to improve service reliability, performance and quality.**
- **Define Tactical Service Design Patterns**
  - **Identify reusable service design patterns that take into consideration of tactical constraints**
  - **Change service behavior to fit better in the existing constrained tactical environments (e.g. offline mode, adaptive content delivery)**

Technical Solution Strategies (Cont.)

- **Enhance Transport Network Performance**
  - **Improve RF link quality and reliability**
  - **Reduce protocol bandwidth requirements (e.g., protocol header and payload compression)**
  - **Deploy emerging high speed networking technology (e.g., 4G wireless)**
  - **Use self-healing and disruption/delay-tolerant networking technologies (e.g., MANET and DTN)**
  - **Use QoS to provide differentiated service to higher precedence traffic**
- **Define Tactical Network and Service Management Functional Requirements**
  - **Identify the network and service management capabilities and functional features required to support the developed tactical edge service development strategies.**

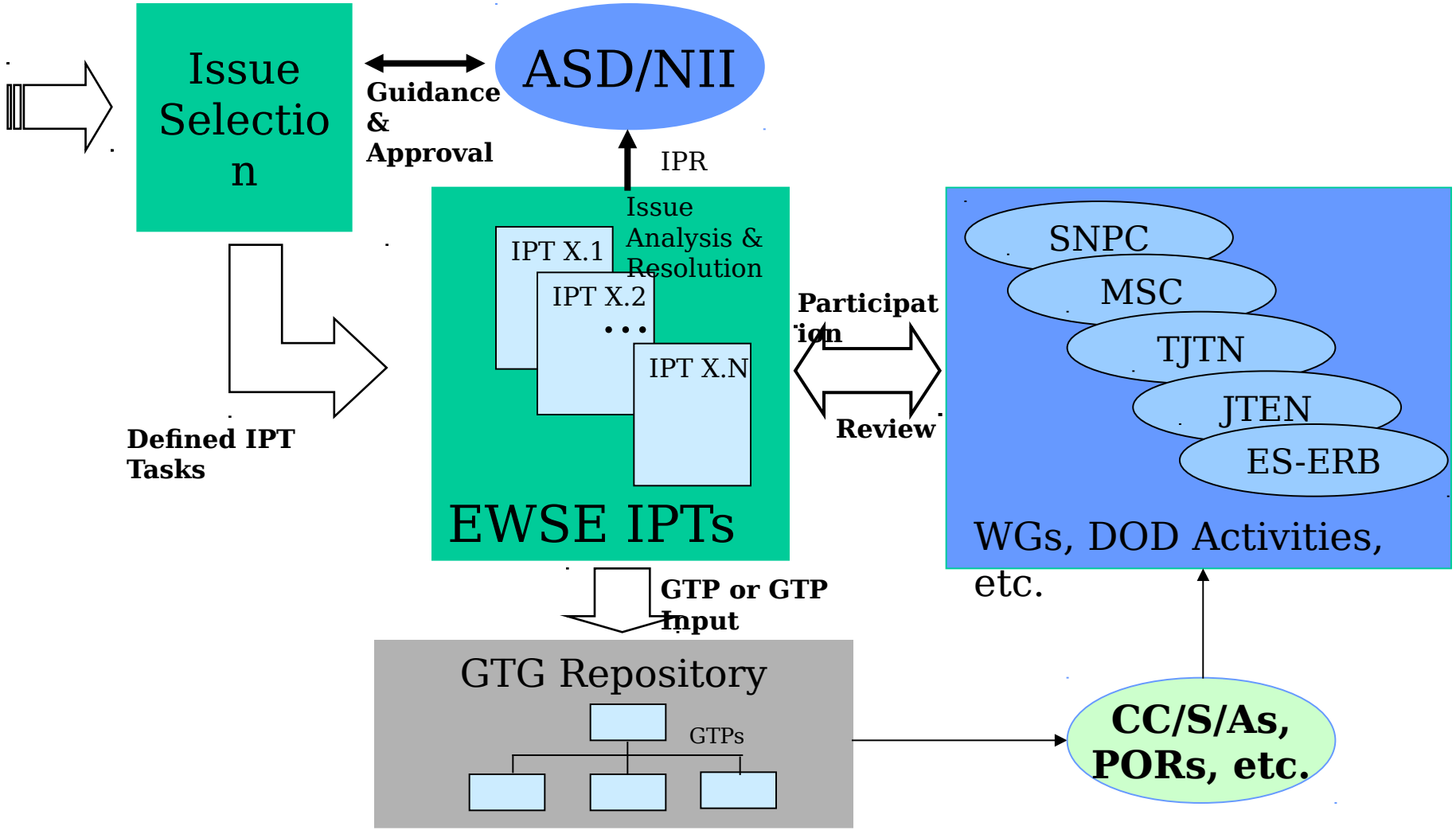
Mapping Design Techniques to Tactical Edge Constraints

Design Techniques Overcoming Tactical Edge Constraints	gh Mobility	sconnected	termittent Connectivity	mited Bandwidth	mited Power Supply	mited Processing Power	inimal Storage	evice Weight	mall UI Size	mited Content	ynamic Topology	gher Link Bit Err Rate	gh Packet Loss Ratio	arger Jitter	ong Latency
Service Adaptation															
Tiered Service		X		X		X	X	X	X	X					
Service broker	X	X	X	X						X					
Proxy Gateway				X		X	X			X					
Tactical Service Desgin															
Adaptive Content Delivery				X		X	X			X	X				
Forward Caching	X	X	X	X											X
Lightweight						X	X	X	X	X					
Safety Critical					X	X	X	X	X						
Run-Time Binding	X	X	X												
Stateful Self-Healing	X	X	X												
Context Free	X	X	X												
Offline Mode	X		X												
Data Compression				X											
Improving Network Performance															
Store and Forward (DTN)	X	X	X								X				
Header/Payload Compress				X											
Network QoS				X									X	X	X
MANET	X	X	X								X				
Wimax/LTE (4G wireless)	X			X											
Adaptive Modulation/Code												X	X		
SCPS-TCP			X												X
Adaptive Power Control						X						X	X		

DISA GIG EWSE Objectives

- **As Executive Agent for the OSD/CIO, DISA GIG EWSE branch:**
  - **Provides DOD level systems engineering support to identify, analyze, and resolve Global Information Grid (GIG) technical issues related to end-to-end interoperability and performance across the GIG programs/domains**
  - **Develops technical analysis reports, reference architectures, standard profiles, interface specifications, and common solutions (patterns)**

Technical Issue Resolution Process



Technical Issue Selection Criteria

- **Relate directly to end-to-end interoperability and performance across GIG programs/systems boundary, not address a specific technical problem for a particular DOD program.**
- **Identify clearly stakeholders/sponsors/customers with large user base in terms of benefits of utilizing the results of issue analysis and resolution.**
- **Can be solved by DISA EWSE based on its available technical resource, funding, and contract support either as a whole or in increment.**
- **Has potential target GIG Technical Profile (GTP) in GIG Technical Guidance (GTG).**

EWSE Technical Areas

- **Align roughly with DOD Information Enterprise Architecture (DIEA) priorities**
  - **Transport (Communications Readiness)**
  - **Applications & Services (Data and Service Deployment)**
  - **Computing Infrastructure (Computing Infrastructure Readiness)**
  - **Net-Centric Operations (NetOps Agility)**
  - **Information Assurance (Secured Availability)**
- **Map to GIG Technical Guidance (GTG) technical segments**

Relevant EWSE Activities

- **Past and Ongoing EWSE Tasks Related to Tactical Edge Service Analysis**
  - **SOA for the Tactical Environment**
  - **Joint Tactical Service Development Guidance**
  - **Federated SOA for GIG Services**
  - **Service Orientation in DIL Environment**
  - **Common Radio Interface to IP Layer**
  - **Inter-Domain Routing in Tactical Networks**
  - **GIG QoS for Tactical Networks**
- **Future EWSE tasks**
  - **We are looking for your input to the type of the problems EWSE needs to work on in the area of tactical edge service at DISA Customer Conference.**
  - **You can also visit our GIG EWSE web to contribute: https://www.intelink.gov/wiki/Portal:GIG_Enterprise_Wide_Systems_Engineering.**

Questions?

https://www.intelink.gov/wiki/Portal:GIG_Enterprise_Wide_Systems_Engineering

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